1082
Y3.T25:2 A-7/2
COMPLETED
75
ORIGINAL
C801

How Clean Is Our Air?

An Assessment of Air Quality in the Tennessee Valley

(35)

I

Foreword

In proportion to the earth's size, the layer of air that surrounds our globe is no thicker than the skin on an apple. A shallow crust on the earth's surface contributes an additional supply of air as well as other resources. This tiny envelope of air and this shallow crust of earth and water form the biosphere. The biosphere is a closed system in which all matter is recycled and reused in support of the life process.

Man, as a part of this closed life system, depends on it for survival. Of all living things, man alone is capable of consciously cooperating with nature to ensure his survival and progress.

Our skill and ingenuity in manipulating the environment have produced tremendous benefits to human life. We have learned to control most of the communicable diseases that once controlled us, to produce bumper crops where none grew before, and to produce energy, light, heat, and consumer conveniences that were once beyond the reach of kings. We used our scientific discoveries and our technological wonders for the purpose of enhancing life, but in the process we gave too little thought to the long-term consequences of our actions. We failed to anticipate the fact that the environmental modifications that have accompanied our good intentions have and will have a global impact on human health and welfare in direct and indirect ways.

The wave of indignation that crested in the 1960's over problems of air and water pollution has led our society to the discovery that we depend on and are part of an ecosystem that we did not invent and must not destroy.

This realization has forced us to ask some fundamental questions. Where and how do we want economic and urban growth? How can we best use and reuse our natural resources? How can we adjust our priorities to ensure that we fulfill our energy, transportation, housing, recreation, and personal consumer needs without intensifying environmental problems we did not anticipate and do not want?

More and more people within our society want to help develop a new quality growth ethic—a way of life that will allow us to retain and improve the life-enhancing features of technology without repeating and enlarging the mistakes of the past. The Tennessee Valley Authority can support this effort and help change the habits and obsolete viewpoints that have led to gross pollution and threats of irreversible environmental damage.

Changing our habits, some of which have gone unquestioned for generations, will not be easy. We have grown accustomed to throwing things away instead of repairing or recycling them. We dump our waste into the water and the air without a second thought. And we waste irreplaceable resources. Now we have the responsibility for developing a new pattern of environmental management. We must become the first generation to work in cooperation, rather than in conflict, with nature.

Meeting our air quality goals will take a generation of hard work. Each must make his own contribution. The combined efforts of individuals, industries, and government at all levels, although they may seem small when viewed separately, can create an enormous impact. A regional commitment, involving each citizen, will not only clear the pollution from our skies and cleanse our waters, it will help propel this region toward a new era of quality growth.

If we act wisely and quickly, we can extract long-range social dividends from our resources, as well as short-term private conveniences. We can elevate the quality of life and expand the quantity of goods. We can set an example for the world by turning from careless exploitation to productive preservation, from growth at any cost to growth for the good of all.

S. David Freeman, Chairman

Richard M. Freeman, Director

Robert Clement, Director

How Clean Is Our Air?

An Assessment of Air Quality In The Tennessee Valley

Prepared by

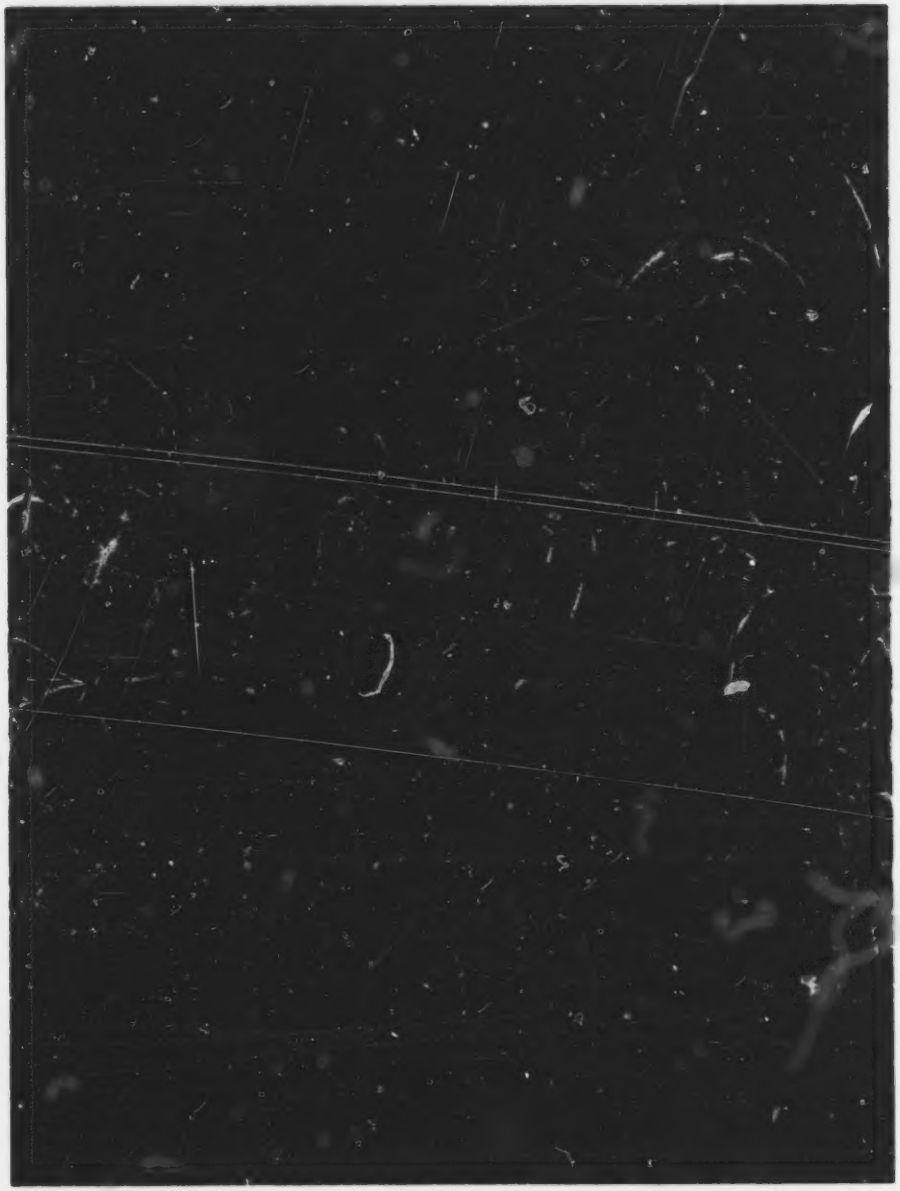
Joseph R. Duncan
William J. Parkhurst
Lawrence M. Reisinger
M. Paul Schmierbach

Edited by
Bonnie C. Winsbro

TENNESSEE VALLEY AUTHORITY
OFFICE OF NATURAL RESOURCES
T. H. Ripley, Manager

DIVISION OF NATURAL RESOURCES SERVICES
B. W. Brown, Jr., Director

AIR QUALITY BRANCH
J. P. Blackwell, Chief



Acknowledgment

The Division of Natural Resources Services, Air Quality Branch, would like to thank the local and State agencies that have contributed air quality data, emissions data, and information on the State Implementation Plan revisions. Local agencies included the Huntsville Air Pollution Control Department, Chattanooga-Hamilton County Air Pollution Control Bureau, Knox County Air Pollution Control Department, Metropolitan Health Department of Nashville and Davidson County, Pollution Control Division, and Memphis and Shelby County Health Department Pollution Control Section. State agencies contacted were the Alabama Air Pollution Control Commission, Tennessee Division of Air Pollution Control, and Kentucky Department for Natural Resources and Environmental Protection, Division of Air Pollution Control. Ambient air quality data summaries were provided by the Region IV Office of the Environmental Protection Agency.

Table of Contents

	Page
Introduction	3
Sources and Effects of Air Pollution	4
Total Suspended Particulates	6
Sulfur Dioxide	7
Nitrogen Dioxide	8
Carbon Monoxide	9
Hydrocarbons	10
Ozone	11
Lead	11
Ambient Air Quality Standards	12
Air Quality in the Tennessee Valley Region	13
Total Suspended Particulates	14
Sulfur Dioxide	16
Nitrogen Dioxide	18
Carbon Monoxide	19
Ozone	20
Ensuring Clean Air	21
Improving Dirty (Nonattainment) Areas	22
Protecting and Maintaining Clean (Attainment) Areas	27
Managing the Air Resources	30

Introduction

Take a look around. What do you see? Take a deep breath. What do you smell? How dirty is the air in your community?

Normally, the atmosphere cleans itself through the natural processes of rain and winds. When these natural processes cannot cope with the increasingly heavy loads of pollutants that are being emitted in some areas, air pollution can become a serious problem.

It would be nice if air could be purified before breathing, just as water is purified before drinking. Instead, we are forced to inhale with each breath any pollutants present in the air around us. Because little technology exists for filtering out pollutants already in the air, we can clean up our atmosphere only by reducing our emissions.

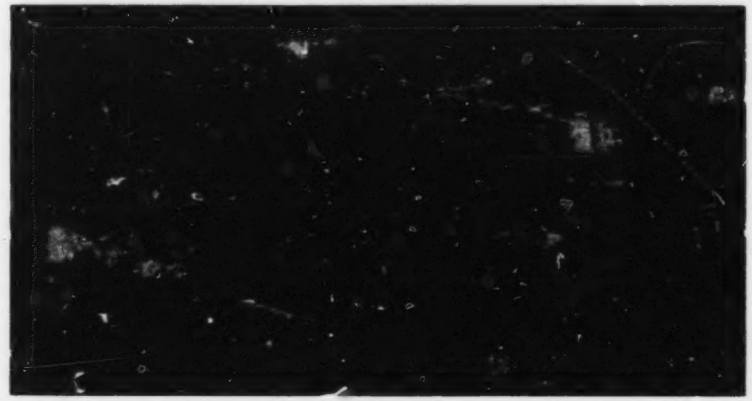
The emission of pollutants into the atmosphere is a by-product of our industrialized, motorized, demanding society. Our society wants and demands more of everything—more jobs, more cars and highways, more energy use in the home, and more consumption of industrial products. One cigarette, one automobile, one chimney, or one industrial stack may be harmless—but when concentrated in a small area, each source of pollution becomes significant, may even be dangerous.

Dirty air is the price that has been paid for national abundance and plenitude. Industry usually bears the blame, whether deserved or not, for degrading our atmosphere. In reality, however, industry is often the villain because of individual demands. Every product we consume leaves a trail of pollution—as it is produced, transported, sold, used, and finally discarded.

Along with our material demands, we also want and demand clean air. In fact, clean air has become a national goal. Through governmental regulation and legislation, it is the intent of Congress to clean up air where it is dirty, maintain clean air where it exists, and preserve those rare and special pristine areas in national parks and wilderness areas.

Protecting air quality while satisfying individual demands for industrial products and community growth will require careful planning and decision-making. What types of pollution control devices should be installed on existing plants? What new types of industry can be developed, and where can new industry be located to prevent deterioration of air quality? Are alternative methods of transportation feasible? What means are available for further development in areas that are already dirty? What can be done now to ensure quality growth in the future?

A first step to answering these questions is to develop an understanding of (1) the sources and effects of the principal air pollutants; (2) the status of air quality in urban, nonurban, and rural areas of the Tennessee Valley region; and (3) the legislative and regulatory mechanisms being used to achieve national clean air goals. This knowledge can then be used to identify opportunities for effectively managing air resources in the Tennessee Valley.



The electricity in our homes can be traced back, over miles of transmission lines, to a major source of pollution. Coal-fired steam plants are the most significant source of sulfur dioxide emissions in the Valley. TVA is providing sulfur dioxide controls for its plants that will reduce emissions and meet air quality standards by 1983.

Sources and Effects of Air Pollution

Everyone has his own definition of air pollution. Most of us probably describe air pollution by its effects on our health or well-being. Air pollution burns our eyes, irritates our throats, or aggravates our sinus problems and respiratory ailments. We complain that the air smells bad or that the air is so dirty we can't see our mountains, our horizons, or our blue skies.

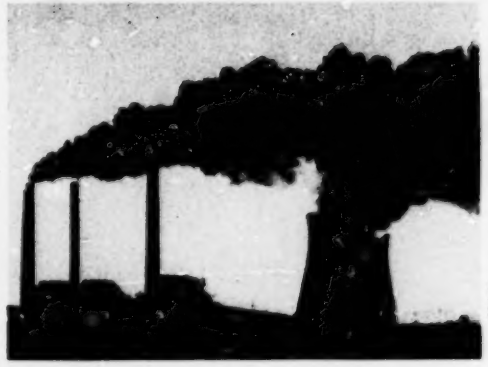
Transportation—by car, truck, bus, or plane—is the largest pollution source in urban areas.

Many airborne contaminants are present in ambient (outside) air in concentrations that are not harmful to human health and welfare. Air pollution occurs only when one or more of these airborne contaminants are present in sufficient quantity and for sufficient duration to harm human health, property, or welfare.

Pollutants come from both natural and man-made sources. Natural sources include volcanic activity, forest fires, wind-blown dust, and biological decay. Although natural emissions often far outweigh man-made emissions on a global scale, man-made emissions usually have the greatest impact in an urban, highly industrialized area.

Man-made air pollution sources are classified as mobile or stationary sources. Mobile sources, which include airplanes, automobiles, trucks, and buses, account for more than 50 percent of the pollution nationwide and in our region. The family automobile is the principal contributor to mobile source pollution. Stationary sources include power plants, industry, home heating, and refuse burning.

Air pollution sources are also classified as point sources or area emission sources. Point sources are those single stationary sources, such as steel mills or power plants, that are large enough to significantly impact air quality. Area sources are small sources, such as emissions from home heating units or dusts from streets and farmers' fields, which although individually small, can collectively cause a major impact.

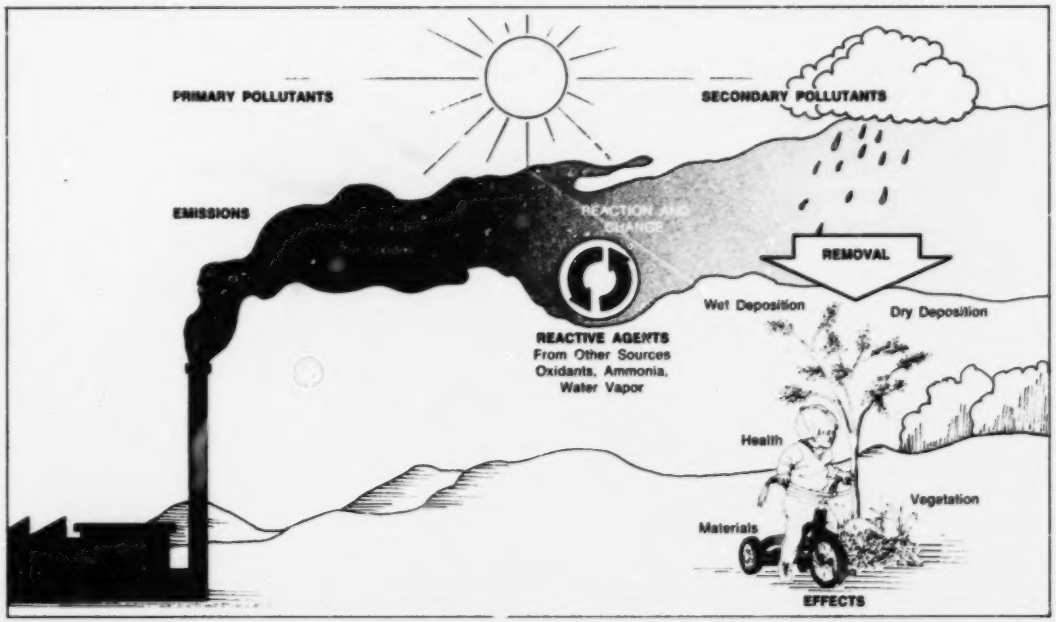


Stationary sources range from small individual sources—home heating and open dumps—to the large steam plants and industrial processes. All sources, whether large or small, contribute to air pollution.

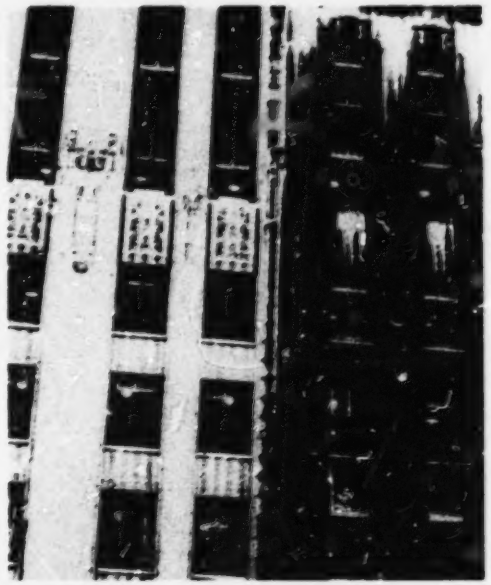
11/80

Pollutants that are emitted directly from their source in gas, liquid, or solid form are called primary pollutants. Primary pollutants affect human health and welfare in the form in which they are emitted. Other compounds are relatively harmless when they are first emitted. But as they are carried downwind, these compounds react with other compounds in the air and are converted into new, potentially more harmful forms. These newly formed pollutants are called secondary pollutants.

Both primary and secondary pollutants may harm human health and welfare. Air pollution can increase the incidence of respiratory ailments; injure vegetation and decrease crop yield; rust metals, discolor house paint, soil and rot clothing; and reduce visibility. Although any contaminant in excess can cause injury, most air pollution damage is caused by one of seven principal pollutants: total suspended particulates, sulfur dioxide, nitrogen dioxide, hydrocarbons, carbon monoxide, ozone, and lead.



Primary pollutants are emitted directly from an emission source. These react with other emissions, some of them harmless compounds, to form secondary pollutants as they travel downwind from the source. These processes, which carry pollutants long distances and change one compound to another, add to the complexity of air pollution problems.

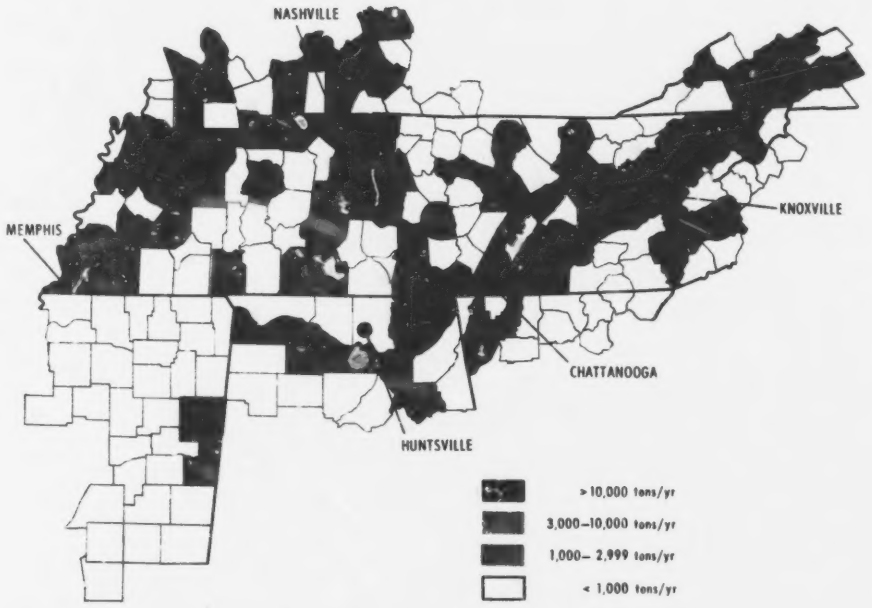


The materials damage caused by excess pollution requires periodic maintenance and repair.

Although small quantities of sulfur dioxide are beneficial to vegetation, excess concentrations can damage leaves and reduce crop yields.

Total Suspended Particulates

Total suspended particulates are composed of small liquid and solid particles that range in size from those visible as soot or smoke to those too small to be seen without a high-power microscope. The largest of these particles remain in the atmosphere for only a few hours, whereas the smallest, remaining aloft for several days, can be carried great distances by winds. Total suspended particulates may be directly emitted from their source as a liquid or solid (primary particulates) or as a gaseous emission that is transformed to a particle in the atmosphere (secondary particulates).



Regional emissions density—total suspended particulates.

Total suspended particulates have both natural and man-made sources. Natural sources include the ocean, volcanic activity, forest fires, wind-blown soil, and biological activity. Important man-made sources include the internal combustion engine, incinerators, manufacturing and industrial processes, fossil-fueled power plants, mining and agricultural activities, and street dust from cars. On a global scale, natural emissions of total suspended particulates far outweigh man-made emissions, but in an industrialized or highly populated area, man-made emissions predominate.

The larger particulates, from 15 to 90 micrometers, are not especially hazardous to health because they are usually filtered out in the nose and throat. Particulates less than 15 micrometers are readily inhaled into the lungs and therefore constitute a potential health threat. The specific effects of these smaller, inhalable particulates are determined by their chemical composition.

Smaller particulates also reduce visibility and increase the acidity in rain. Acidic rain may affect vegetation and increase acidity in streams above levels tolerable by aquatic organisms.

In cities or industrial areas, the larger particulates can soil cloth and paint and, in the presence of some acidic gases such as sulfur dioxide, can accelerate corrosion of metals. Vegetation can be slightly damaged when particulates, covering leaves, reduce sunlight exposure.

Sulfur Dioxide

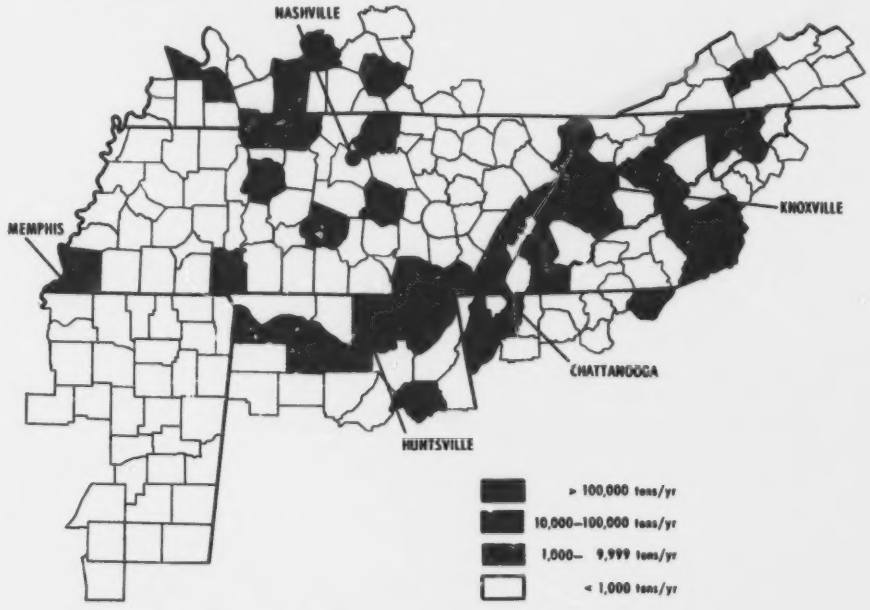
Sulfur dioxide is a colorless and, at ambient levels, odorless gas. The only significant natural sources of sulfur dioxide are biological decay and volcanic activity. Large man-made sources include fossil-fueled power plants, industrial processes, and ore smelters. In industrialized countries, the amount of sulfur dioxide formed through man's activities greatly exceeds the amount from natural sources.

Sulfur dioxide was originally thought to be one of the principal toxic compounds of the deadly pollution episodes of the Meuse Valley, Belgium (1938); Donora, Pennsylvania (1948); and London, England (1952). Since that time, health investigators have confirmed that, by itself, sulfur dioxide is a relatively mild irritant that does not travel below the upper respiratory tract. However, in combination with inhalable particles, which may carry it into the lower part of the lungs, sulfur dioxide is much more toxic and may cause respiratory ailments, particularly in sensitive individuals.

The vegetative effects of sulfur dioxide have been widely researched. Sulfur dioxide can injure vegetation growing near large emissions sources and sometimes may reduce crop yield. An extreme case of vegetation damage by sulfur dioxide occurred in Copperhill, Tennessee, near the turn of the century. Emissions from a copper smelting facility destroyed vegetation over an area of 25 square miles. As vegetation was destroyed, the topsoil eroded, leaving a denuded landscape as a reminder of man's ability to destroy the environment.

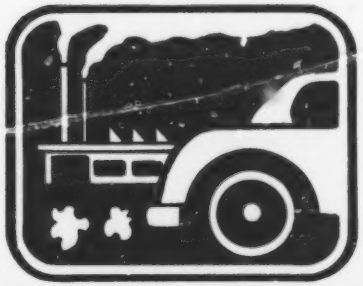
Sulfur dioxide can also damage various materials when it combines with water to form sulfurous and sulfuric acids. Sulfur dioxide emissions also increase acid levels in rain and, after being transformed into particulate sulfate in the atmosphere, reduce visibility.

The bare, eroded landscape around Copperhill, Tennessee, is one of the most extreme examples of vegetation damage by sulfur dioxide.



Regional emissions density—sulfur dioxide.

Nitrogen Dioxide

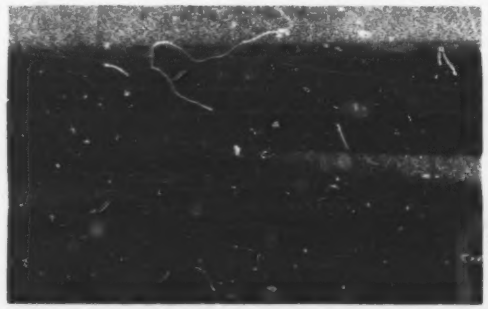


Nitrogen dioxide is a reddish-brown, pungent gas, which can be a primary emission. In most cases, however, both natural and man-made nitrogen dioxide is formed as a result of atmospheric reactions that involve the oxidation of nitric oxide.

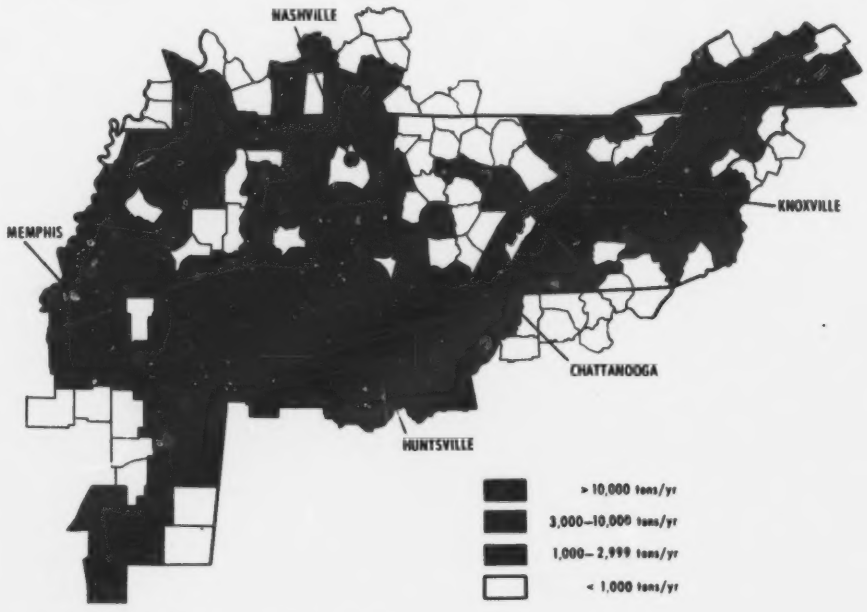
Natural sources of nitric oxide include biological decay and forest fires. These natural sources, particularly biological decay, produce far greater amounts of nitric oxide than do man-made sources. Nevertheless, in localized areas, it is the man-made sources that cause significant pollution problems. The automobile and large stationary sources, such as fossil-fueled power plants and industrial processes, are the largest emission sources of nitric oxide. Nitrogen dioxide can also react with other substances to produce ozone, another major pollutant.

Nitrogen dioxide is a relatively insoluble gas that is capable of penetrating the lungs. In high concentrations, nitrogen dioxide, like most pollutants, is quite toxic. At ambient levels, however, it does not appear to cause respiratory damage.

Nitrogen dioxide rarely occurs in sufficiently high concentrations to damage crops, but it can cause material damage to paints and dyes. Nitrogen dioxide also contributes to the acidification of rainfall and visibility reduction, both as a gas and as a precursor to particulate nitrate and nitrite. (Precursor compounds are those which, through reactions with other chemicals in the air, are changed into new compounds.)

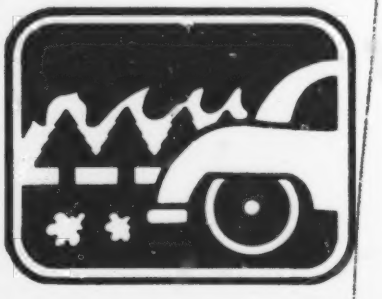


Plumes from coal-fired steam plants carry pollutants far downwind, crossing geographical and political boundaries.



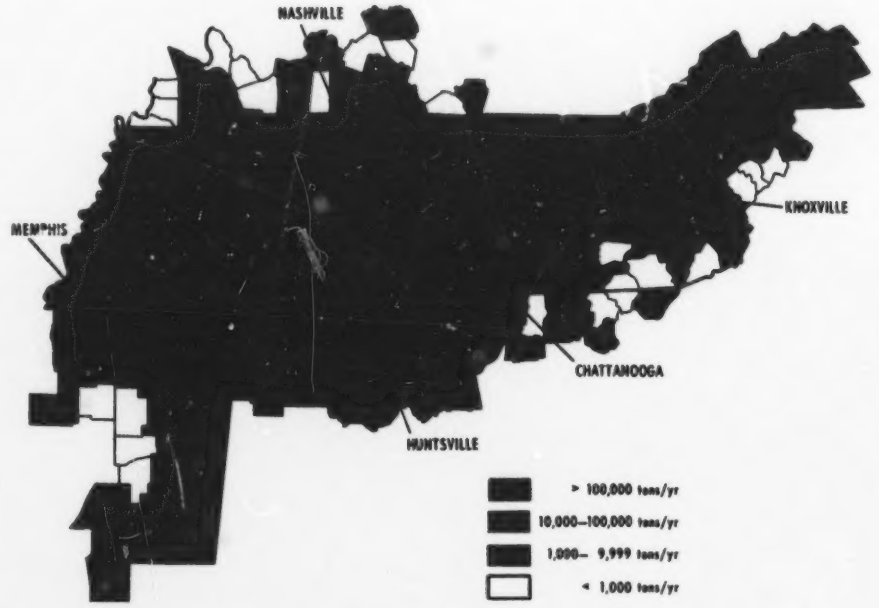
Regional emissions density—nitrogen dioxide.

Carbon Monoxide



Carbon monoxide, a colorless, odorless gas, is formed as a result of incomplete combustion. Emitted directly from its source, carbon monoxide is a primary pollutant. Natural sources of carbon monoxide include forest fires and respiration by mature plant leaves and plankton. The primary man-made source is the internal combustion engine.

The effects of carbon monoxide on human health are well known. The presence of carbon monoxide in the air increases levels of carboxyhemoglobin in the blood. In high concentrations, carboxyhemoglobin can significantly reduce the oxygen-carrying capacity of the blood. At ambient levels, carbon monoxide presents a potential risk only in urban areas with heavy traffic. Carbon monoxide does not affect vegetation or materials, but is a reactor in the production of another major pollutant, ozone.



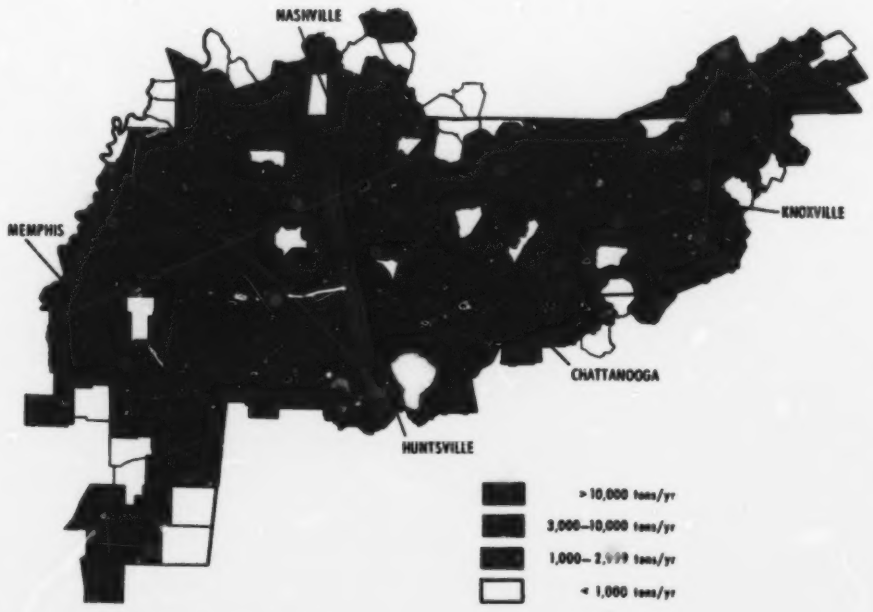
Regional emissions density—carbon monoxide.

Hydrocarbons

Hydrocarbons include a wide variety of highly reactive organic compounds. Although usually emitted as primary pollutants, hydrocarbons, because of their high reactivity, can readily alter their composition.

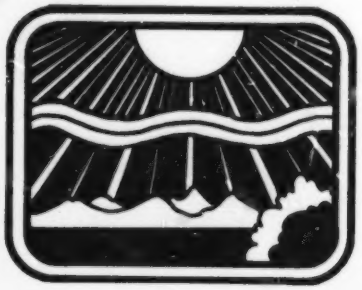
Man-made sources are relatively insignificant on a global scale when compared with the natural sources. The principal natural sources are vegetation, forest fires, marshes, and natural gas, oil, and coal fields. The principal man-made sources include internal combustion engines and petroleum refining and handling.

The toxicity of hydrocarbons depends on their composition. The importance of hydrocarbons, as an air pollutant, is the role they play in producing ozone and other irritating compounds.



Regional emissions density—hydrocarbons.

Ozone



Ozone, a highly reactive oxidant gas, has a pungent odor and a blue tint. Ozone is a by-product of a complicated series of atmospheric photochemical reactions, involving nitrogen oxides, hydrocarbons, and carbon monoxide.

Ozone is produced from both natural and man-made activity. In the upper atmosphere—the stratosphere—ozone is produced naturally in the presence of oxygen, nitrogen oxides, and intense ultraviolet radiation. Ozone produced in the stratosphere protects the earth's surface from dangerous levels of ultraviolet radiation. Substantial amounts of ozone from this stratospheric layer occasionally enter the lower atmosphere—the troposphere—by natural processes.

Ozone is also produced in the troposphere from natural emissions of hydrocarbons and nitrogen oxides. Usually, however, the highest levels of ozone in the troposphere are found some distance downwind from urban areas that have a high density of man-made emissions. High levels of ozone are seldom found near the precursor emission source because ozone is consumed in the primary oxidation processes. After oxidation, however, the secondary emission by-products lead to net ozone production.

The principal source of man-made primary emissions is the internal combustion engine. Although ozone itself is not a primary emission, the relative density of its precursor emissions (nitrogen oxides, carbon monoxide, and hydrocarbons) throughout the Valley can provide a clue to its source regions.

In the concentrations often found in urban areas, ozone may irritate the eyes, nose, and throat. The symptoms of acute exposures—that is, exposures to high concentrations for short periods of time—come and go. Chronic exposures, or exposures to low or ambient concentrations for long periods of time, apparently do not cause permanent injury. Ozone, and photochemical oxidants in general, can damage vegetation during acute exposures. Leafy vegetables, such as lettuce, cabbage, tobacco, and spinach, seem particularly susceptible. Ozone can also damage materials such as rubber, plastics, dyes, and paints.

Lead

Lead is a gray-white metal, which exists in the atmosphere in various particulate forms. At ambient concentrations it is odorless and invisible to the human eye. The primary natural source of airborne particulate lead is the soil. The largest man-made source of particulate lead is the gasoline-powered internal combustion engine, where small quantities of tetraethyl lead are used in gasoline as an antiknock compound. Lead emissions can also become a localized problem near lead smelters and storage battery plants.

About 80 percent of airborne particulate lead is in the fine particulate size range (less than 2.5 micrometers in diameter), which is readily inhaled into the lungs. Although the principal pathways by which lead enters the human body are through ingestion of food and water, particulate lead trapped in the lungs also contributes to the total amount of lead in the body. Elevated levels of lead in the body adversely affect the blood, nervous system, and kidneys. A natural constituent of soil, lead does not pose a significant threat to vegetation or materials.

Ambient Air Quality Standards

The Clean Air Act of 1970 directed the Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) for pollutants that were determined to adversely affect public health and welfare. Standards for total suspended particulate matter, sulfur dioxide, ozone, nitrogen dioxide, carbon monoxide, and hydrocarbons were set in 1971. Lead was added in 1977 as the seventh criteria pollutant, and a standard was set in 1978.

Federal regulations specify both a primary and secondary NAAQS. The primary standard protects human health, and the secondary standard protects public welfare (vegetation, materials, and visibility). Each standard refers to an allowable concentration over a specified averaging time. The long-term standards, averaged over a year, quarter, or a month, are never to be exceeded. The short-term standards, for 24-, 8-, 3-, and 1-hour periods, are not to be exceeded more than once during a calendar year.

The NAAQS are subject to change. The Clean Air Act Amendments of 1977 established a timetable for periodically reviewing the existing standards and adopting new ones. The ozone standard, originally set in 1971, was revised in February 1979. A new standard for nitrogen dioxide is being considered. Research in progress may lead to criteria definitions and new NAAQS for sulfates and inhalable particles. This ongoing review will allow consideration of new scientific evidence about effects on health and welfare.

NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant and time period*	Standards (micrograms per cubic meter)	
	Primary	Secondary
Total suspended particulates		
Annual	75	60
24-hour	260	150
Sulfur dioxide		
Annual	80	
24-hour	365	
3-hour		1300
Nitrogen dioxide		
Annual	100	100
Carbon monoxide		
8-hour	10,000	10,000
1-hour	40,000	40,000
Hydrocarbons		
3-hour	160	160
Ozone**		
1-hour	240	240
Lead		
3-month	1.5	

*Short-term standards (24 hours and less) are not to be exceeded more than once a year. Long-term standards are maximum permissible concentrations that are never to be exceeded.

**The ozone standard was changed in February 1979 from 160 to 240 micrograms per cubic meter.

Air Quality in the Tennessee Valley Region*

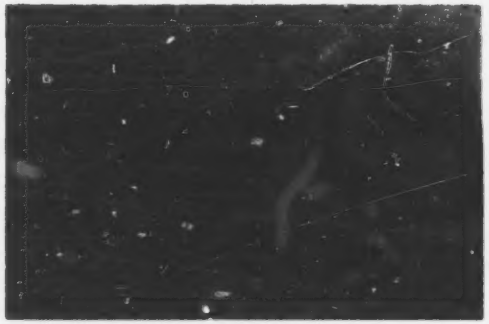
Air quality is generally good in those parts of the Tennessee Valley that are located away from obvious major sources of man-made pollution. The undeniable fact remains, however, that even nonurban industrialized areas of the Valley experience air pollution. Most of this pollution results from natural and man-made sources in the Valley region. Yet at times air quality in the region is affected by pollution that is produced outside the Tennessee Valley and transported in by large airmasses moving across the country.

Five monitoring stations, the TVA Regional Air Quality Trend Stations, have been specifically sited to determine air quality in areas far from large man-made sources. These stations are located in Trigg County, Kentucky; Jackson County, Alabama; Washington County, Virginia; and Giles and Monroe Counties, Tennessee. In most instances, they provide a reasonable comparison of ambient air quality levels in these areas.

TVA's Air Quality Branch monitors air quality at 104 stations throughout the Tennessee Valley. State and local agencies operate 189 stations. Together, all Federal, State, and local agencies monitor air quality in 103 of the 201 counties included in the Tennessee Valley region.

Sixteen nonurban counties (counties that contain cities with less than 200,000 population) in the Tennessee Valley are subjected to significant air pollution: Colbert, Jackson, Lauderdale, and Morgan Counties in Alabama; Marshall, McCracken, and Muhlenburg Counties in Kentucky; and Anderson, Benton, Campbell, Humphrey, Maury, Polk, Roane, Sullivan, and Sumner Counties in Tennessee. Each of these counties, in whole or in part, has violated the NAAQS for one or more of the criteria pollutants.

Urban areas have long been the focus of air pollution studies because (1) high emissions density produces high ambient pollution levels, and (2) a large population is at risk. The metropolitan areas of the Tennessee Valley are no exception. The five large urban areas—Knoxville, Nashville, Memphis, and Chattanooga, Tennessee, and Huntsville, Alabama—have similar pollution problems. All five have violated the NAAQS for ozone; four have violated the NAAQS for total suspended particulates; and three have violated the NAAQS for carbon monoxide. None of these areas has exceeded the NAAQS for sulfur dioxide or nitrogen dioxide. (Few data exist at this time for hydrocarbons or lead.)



Chattanooga skyline on a clear day.

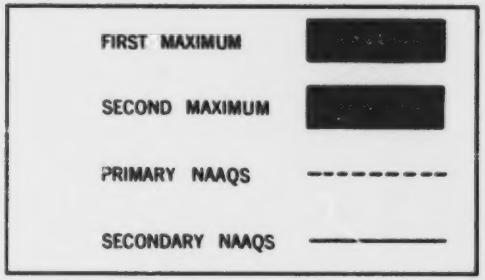
A summer stagnation stalls air movement over Chattanooga, trapping pollution over the city and obscuring the skyline.

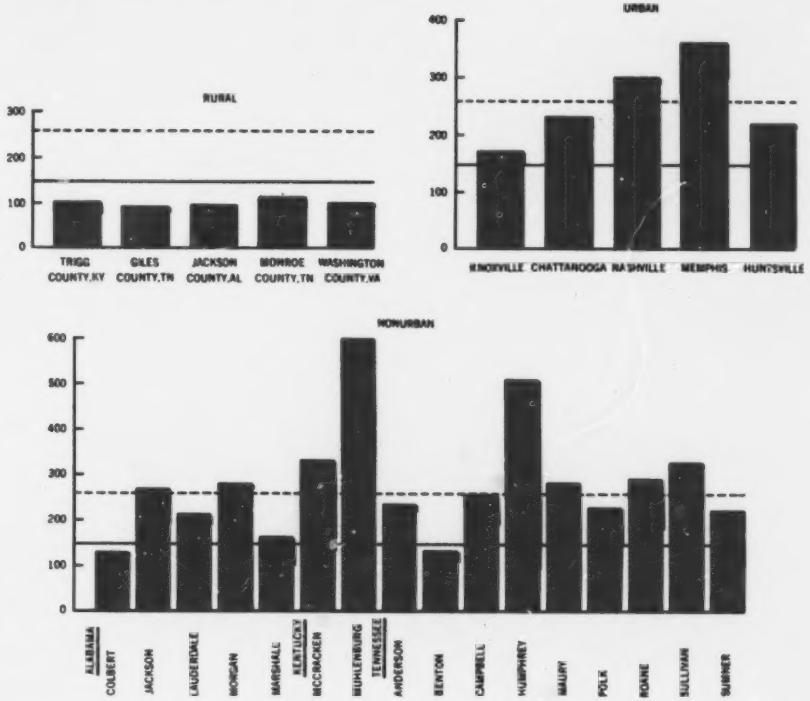
*All air quality data described in this report have been taken from the calendar year 1977, which provided the most recent annual data set available from all Federal, State, and local agencies in the region. The 1977 data also served as the basis for regulatory actions required by the Clean Air Act.

Few data are available for hydrocarbon concentrations in the Tennessee Valley because monitoring is not required for hydrocarbons. Likewise, insufficient monitoring data are available for a full description of lead concentrations throughout the Valley since lead was not included as one of the criteria pollutants until 1977.

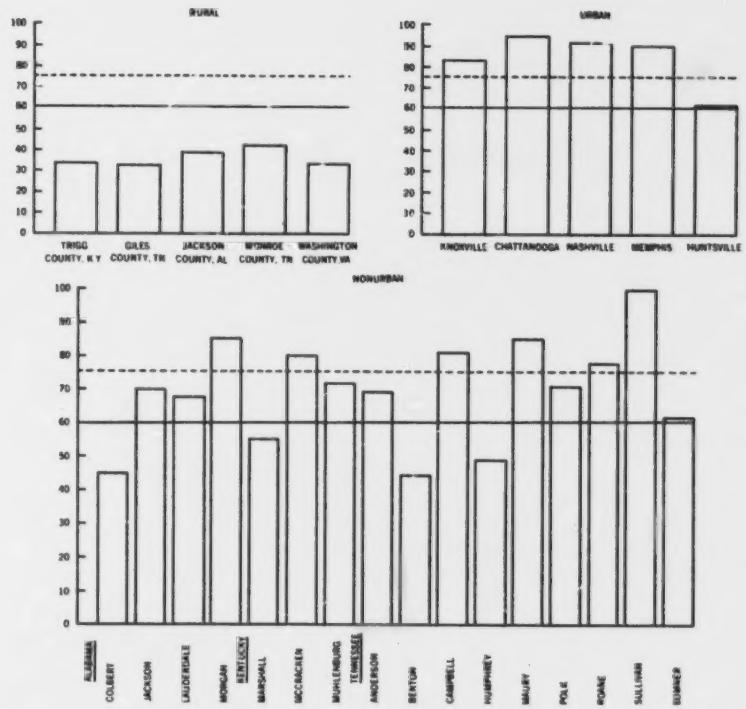
Total Suspended Particulates

The rural monitoring data indicate that neither the maximum annual standard nor the 24-hour standard for total suspended particulates was exceeded. However, all of the urban and most of the 16 nonurban sites violated either the primary or secondary NAAQS.



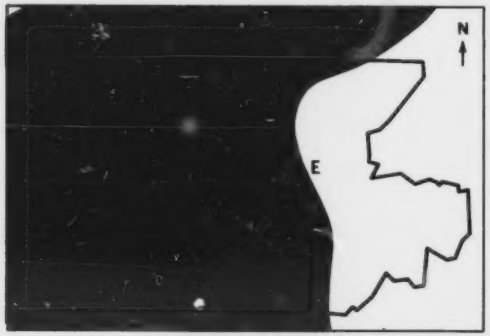


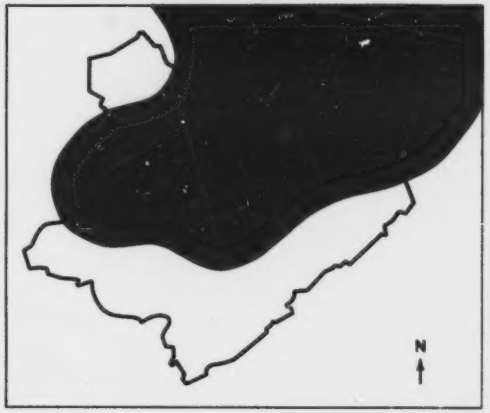
Maximum 24-hour concentrations (micrograms per cubic meter) for total suspended particulates.

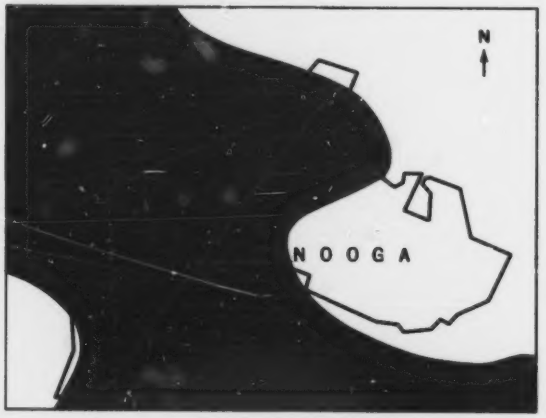


Annual average concentrations (micrograms per cubic meter) for total suspended particulates.

The monitoring networks for total suspended particulates in the five urban areas are sufficiently dense to allow a computerized mapping of the 1977 annual geometric mean concentrations of total suspended particulates. When compared with known census enumeration districts, these computerized maps indicate that about 9 percent of the Knoxville population, 47 percent of the Chattanooga population, 16 percent of the Nashville population, 65 percent of the Memphis population, and 0 percent of the Huntsville population are exposed to particulate levels exceeding the primary annual NAAQS. In comparison, the secondary particulate levels were exceeded over about 50 percent of the incorporated area of Knoxville, 75 percent of Chattanooga, 80 percent of Nashville, 95 percent of Memphis, and 15 percent of Huntsville.







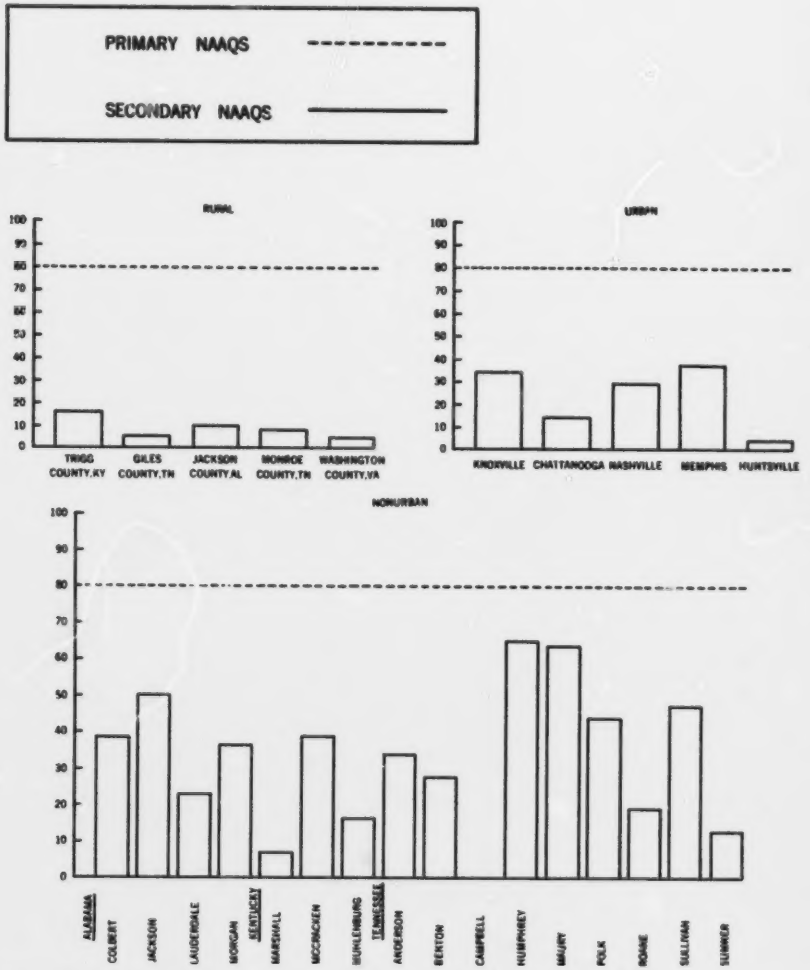
VIOLATION OF PRIMARY STANDARDS (>75 ug/m³)
VIOLATION OF SECONDARY STANDARDS (60–75 ug/m³)
NO VIOLATION (<60 ug/m³)

In 1977 more than 50 percent of the geographical areas of Knoxville, Nashville, Memphis, and Chattanooga exceeded primary and secondary standards for total suspended particulates. Only 15 percent of the Huntsville area exceeded secondary standards.

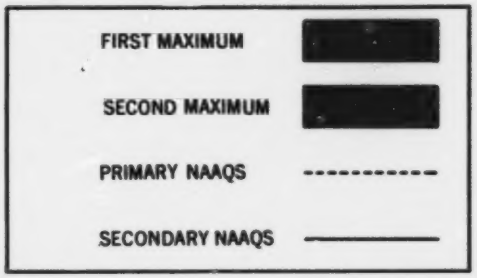
Sulfur Dioxide

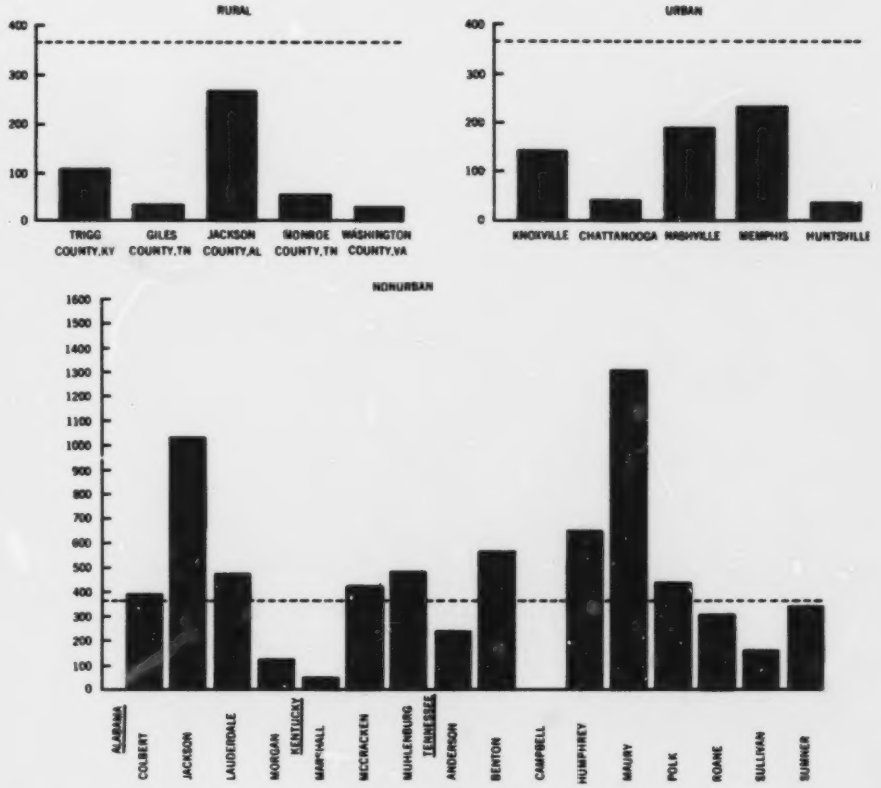
The average annual, maximum 24-hour, and maximum 3-hour NAAQS for sulfur dioxide were not exceeded at any urban monitoring sites. However, the 24- and 3-hour NAAQS are exceeded at one rural and several nonurban sites.

Violations of the short-term standards occur near large emission sources of sulfur dioxide. Except for the violations in Maury and Polk Counties, Tennessee, all violations are related to the operation of TVA coal-fired power plants. The graphic illustrations for short-term (3- and 24-hour) concentrations of sulfur dioxide show that the rural monitoring station in Jackson County, Alabama, is strongly influenced by a large emissions source. However, when averaged over a year, the sulfur dioxide concentrations at the Jackson County station are comparable with those at the other rural stations. Therefore, the most significant impact of this large source was its contribution to high short-term concentrations. It had little effect on annual average levels, which remained well below the primary annual standard.

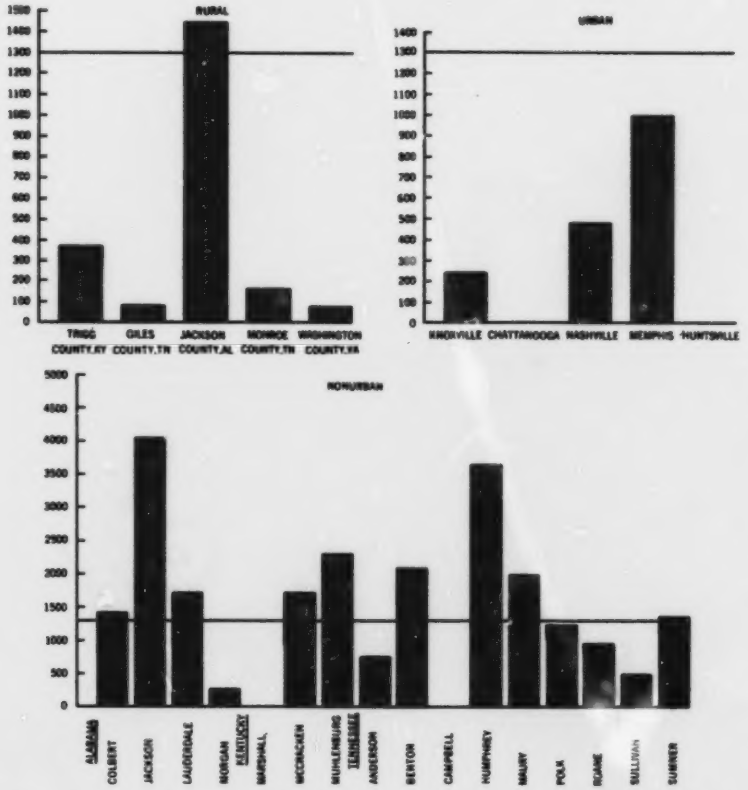


Annual average concentrations (micrograms per cubic meter) for sulfur dioxide.



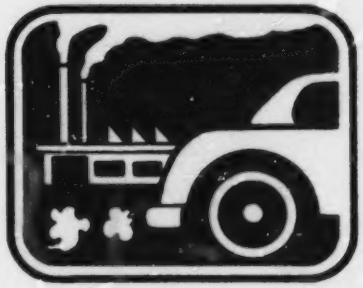


Maximum 24-hour concentrations (micrograms per cubic meter) for sulfur dioxide.

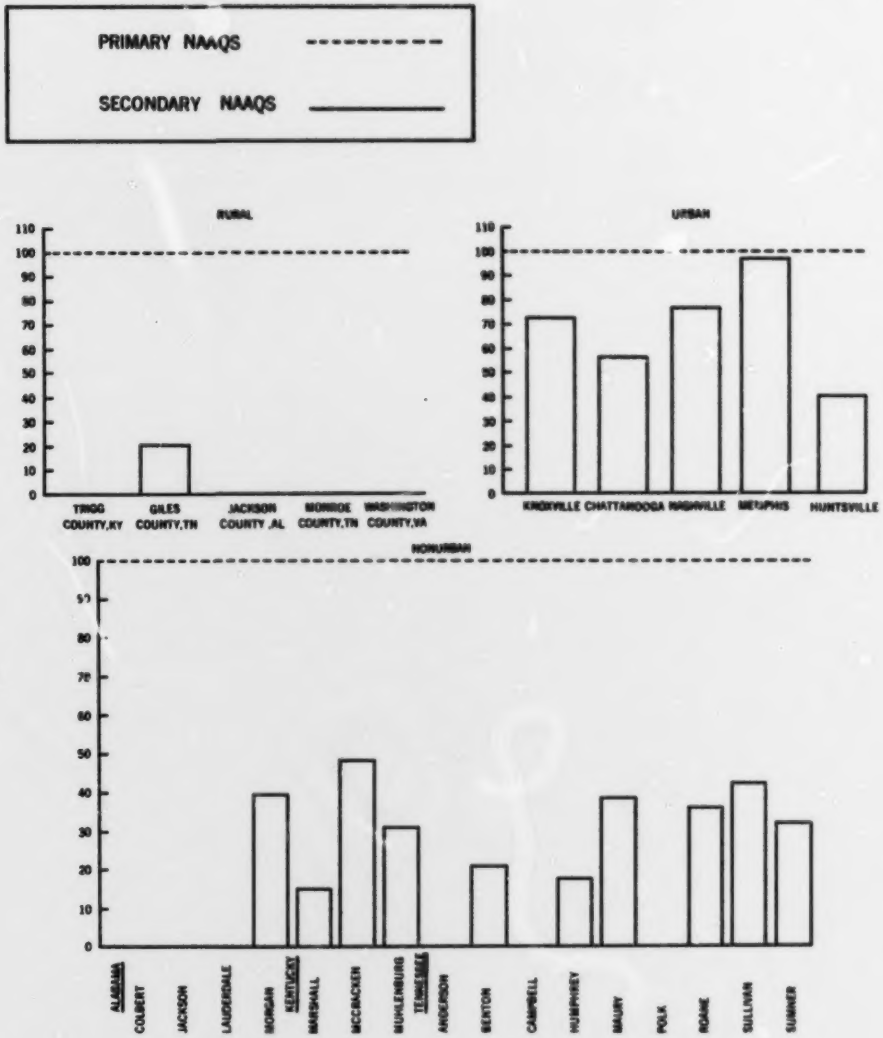


Maximum 3-hour concentrations (micrograms per cubic meter) for sulfur dioxide.

Nitrogen Dioxide



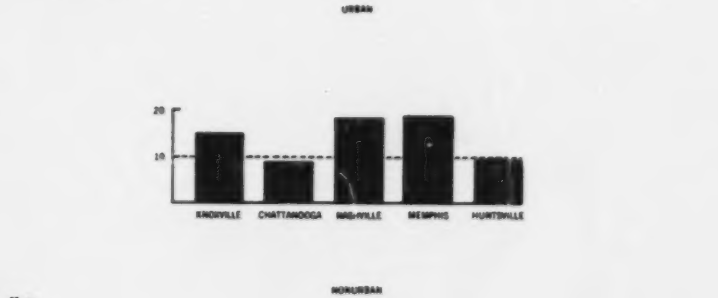
The annual average NAAQS for nitrogen dioxide were not exceeded. In general, the urban areas have the highest concentrations, with the Memphis concentrations approaching the standard.



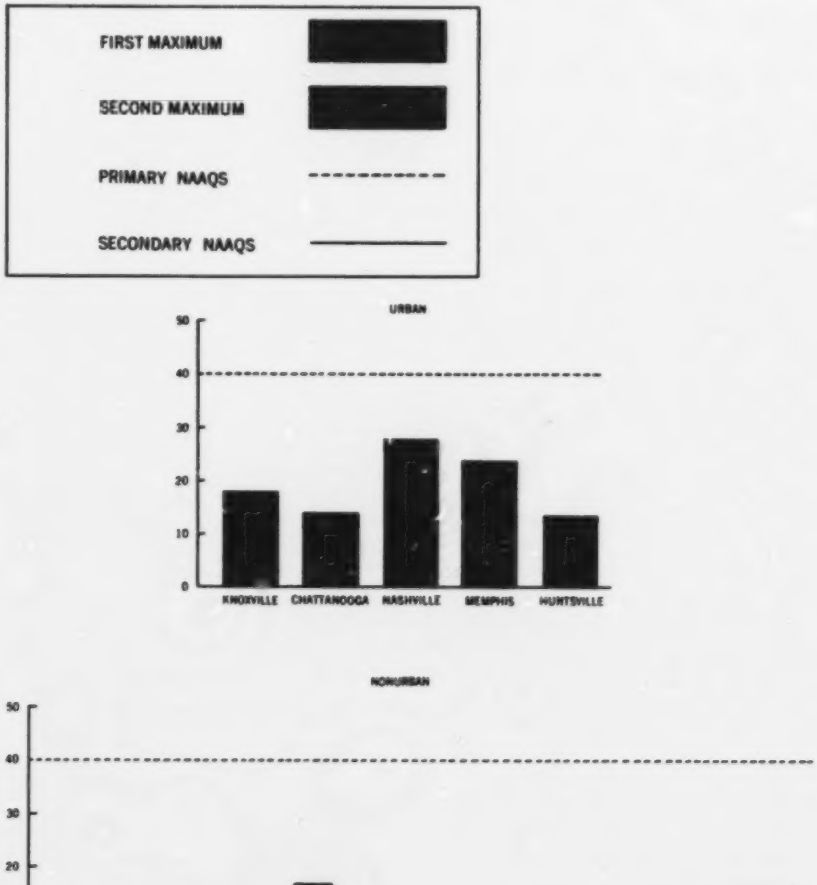
Annual average concentrations (micrograms per cubic meter) for nitrogen dioxide.

Carbon Monoxide

Carbon monoxide concentrations are not monitored in rural areas, and the single nonurban site is located in McCracken County (Paducah), Kentucky. Carbon monoxide is a problem in the urban areas. The maximum 8-hour NAAQS for carbon monoxide is violated at four of six monitoring sites, but the maximum 1-hour NAAQS is not exceeded.

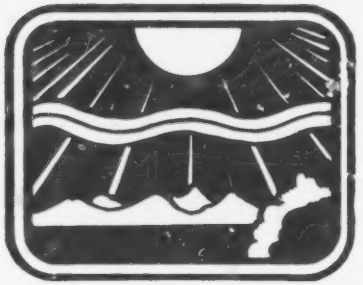


Maximum 8-hour concentrations (milligrams per cubic meter) for carbon monoxide.

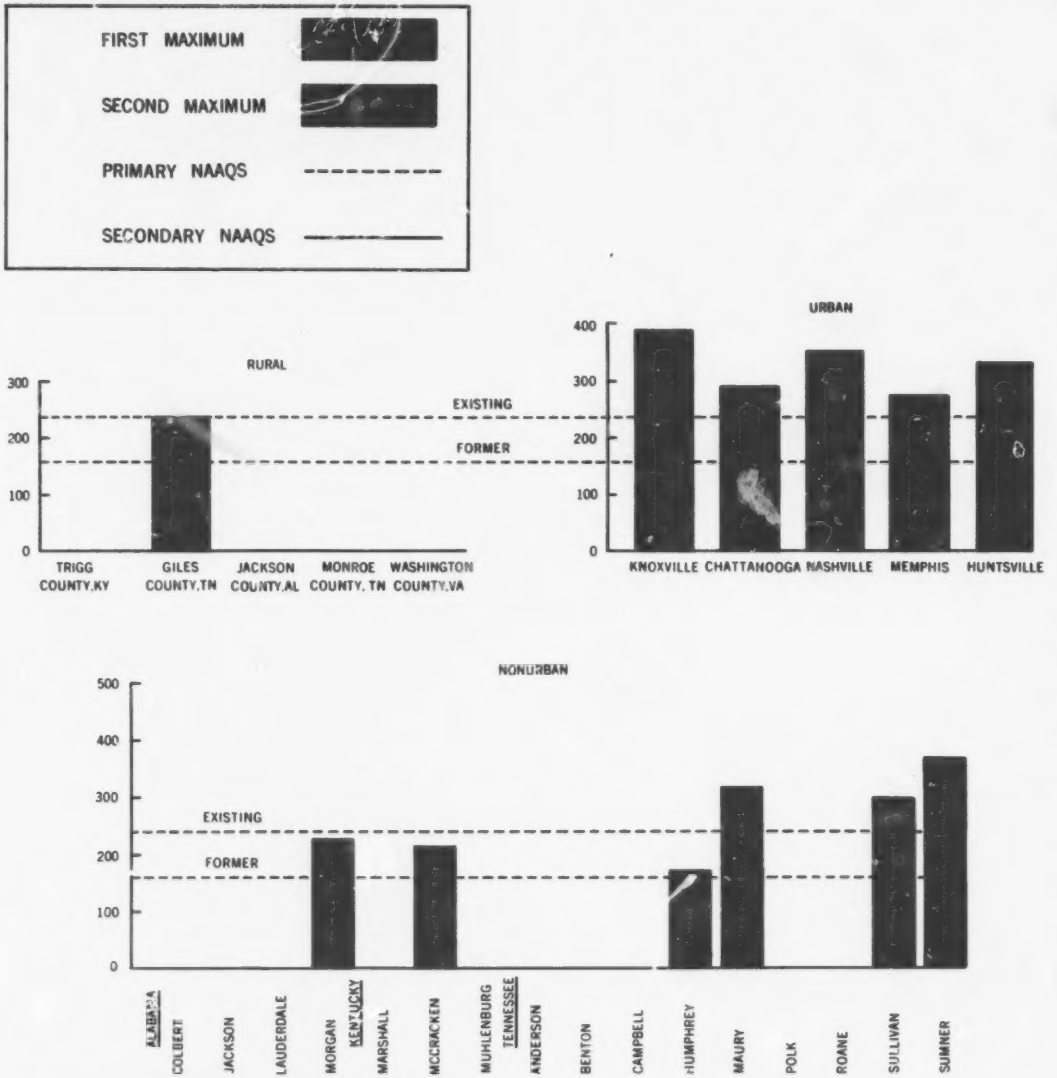


Maximum 1-hour concentrations (milligrams per cubic meter) for carbon monoxide.

Ozone



All monitoring sites violated the former 1-hour NAAQS for ozone of 160 micrograms per cubic meter, and eight of the twelve sites violated the existing NAAQS of 240 micrograms per cubic meter. Ozone violations will probably continue to be a problem in all areas of the Tennessee Valley. Although the man-made sources of ozone precursors (nitrogen oxides, hydrocarbons, and carbon monoxide) are concentrated in the cities, elevated ambient concentrations may occur throughout the region because of the transport and transformation processes involved.



Maximum 1-hour concentrations (micrograms per cubic meter) for ozone.

Ensuring Clean Air

In 1963, Congress expressed concern about air pollution by passing the Clean Air Act. The original Act required State and local agencies to take action to reduce emissions from industrial smokestacks.

Since that time, various Amendments to the Act have called for reduction of motor vehicle emissions, establishment of maximum allowable levels for major pollutants, and delegation of more responsibility to the States for cleaning up the air.

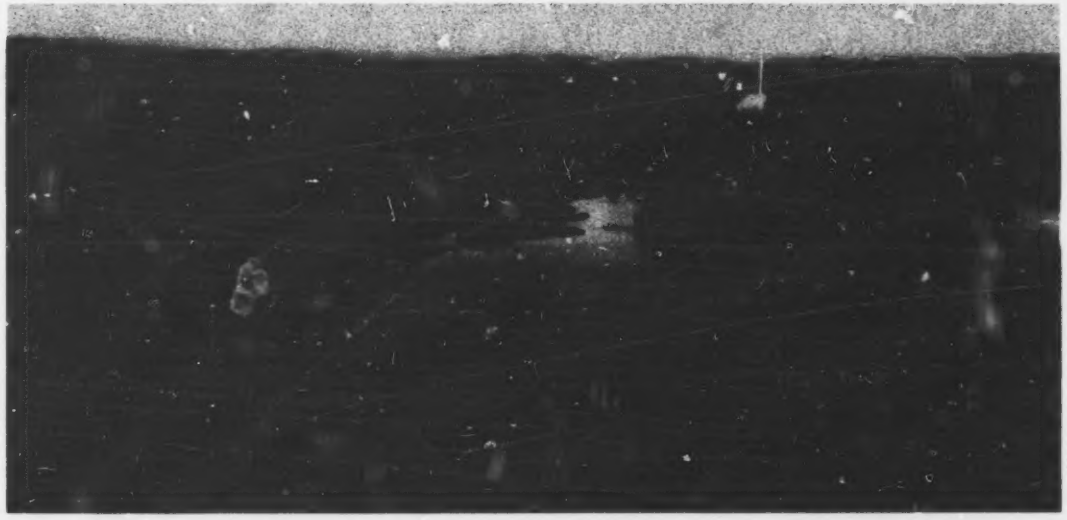
The Clean Air Act Amendments of 1970 gave the States the responsibility for preventing and controlling air pollution at its source. Each State was required to submit, by July 1972, a State Implementation Plan (SIP) to the Environmental Protection Agency (EPA) for approval. This SIP was to outline the State's plans for achieving the NAAQS in dirty areas by 1975 while maintaining and protecting air quality in clean areas.

The early attempts by State agencies to develop SIPs proved inadequate, however, largely because of poor data bases, insufficient time for developing plans, and inadequate analysis techniques. The Clean Air Act Amendments of 1977 required a second look at ambient compliance methodologies. These 1977 Amendments required the States to resubmit plans for attaining primary standards by no later than the end of 1982. The deadline was extended to the end of 1987 for areas particularly complicated by ozone and carbon monoxide problems. Attainment of the secondary standard is required within a "reasonable" time.

With the help of the States, EPA published a list of geographical areas, called nonattainment areas, that are not meeting the NAAQS for five of the seven major pollutants. Although no nonattainment areas exist for nitrogen dioxide in the Valley region, nonattainment areas do exist for total suspended particulates, sulfur dioxide, ozone, and carbon monoxide.

The problem of permitting industrial growth in nonattainment areas was addressed in EPA's Emission Offset Interpretative Ruling issued in 1976. The Clean Air Act Amendment of 1977 essentially incorporated this "offset policy" as part of the Clean Air Act. The offset policy requires that all new sources to be built in a nonattainment area must incorporate pollution control technology that will yield the lowest achievable emission rates possible, regardless of economic considerations. New sources are also required to obtain sufficient reductions in emissions from existing sources in the area to provide (1) an overall decrease in area emissions and (2) a net air quality benefit.

Continued industrial and community growth is a key element in the SIP revision. However, little provision is proposed in any of the planned SIPs for continued growth of major point sources in the Valley region. States are planning for the growth that will result from increases in population and anticipated expansion of existing facilities, but provisions for new facilities are limited. The only apparent means for allowing new growth is to adopt EPA's emission offset policy. The result of this approach is that SIP revisions include plans for complying with NAAQS, but will provide little room for growth of new sources unless emission offsets are obtained by the new source owner.



Siting of power plants and industries to limit environmental impact in the Tennessee Valley will depend on careful, informed land use planning.

Improving Dirty (Nonattainment) Areas

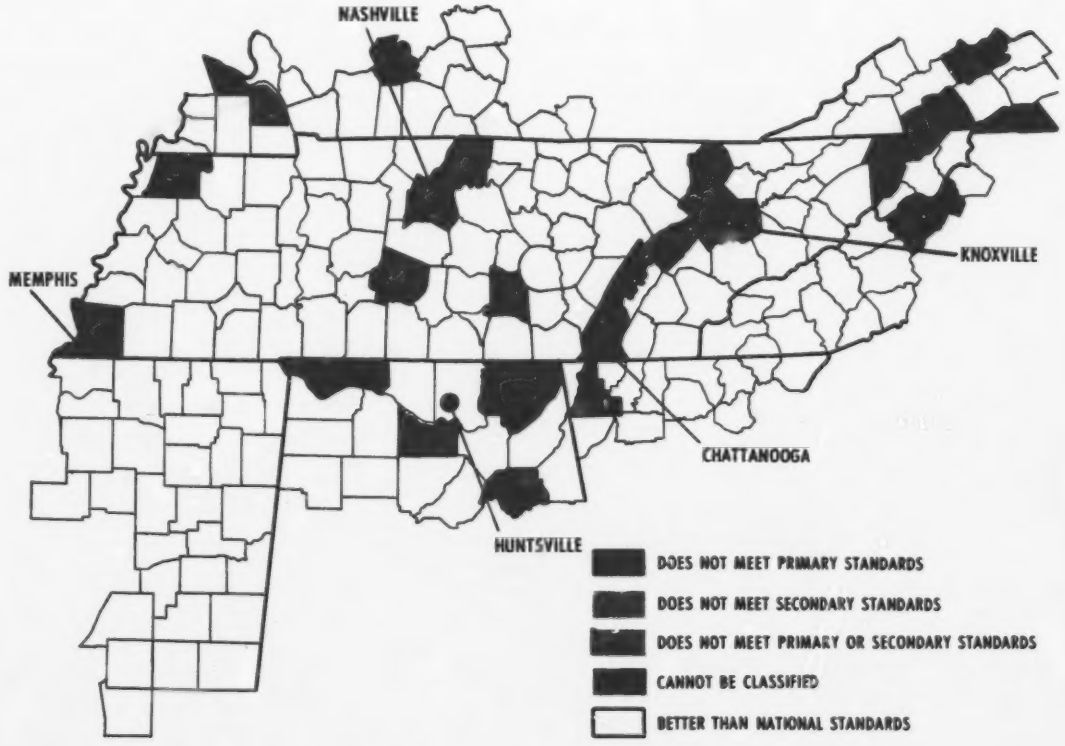
The SIP revision strategies have been developed for cleaning up all nonattainment areas in the Tennessee Valley region. The urban areas—Knoxville, Huntsville, Decatur, Nashville, Memphis, and Chattanooga—are of particular interest because of their actual and potential problems with transportation-related pollutants (ozone, carbon monoxide, and particulates). However, many rural and nonurban areas, also designated as nonattainment areas, have serious problems requiring cleanup strategies.

Total Suspended Particulates—Nashville, Decatur, Chattanooga, and portions of Memphis are violating one or more of the NAAQS for total suspended particulates.

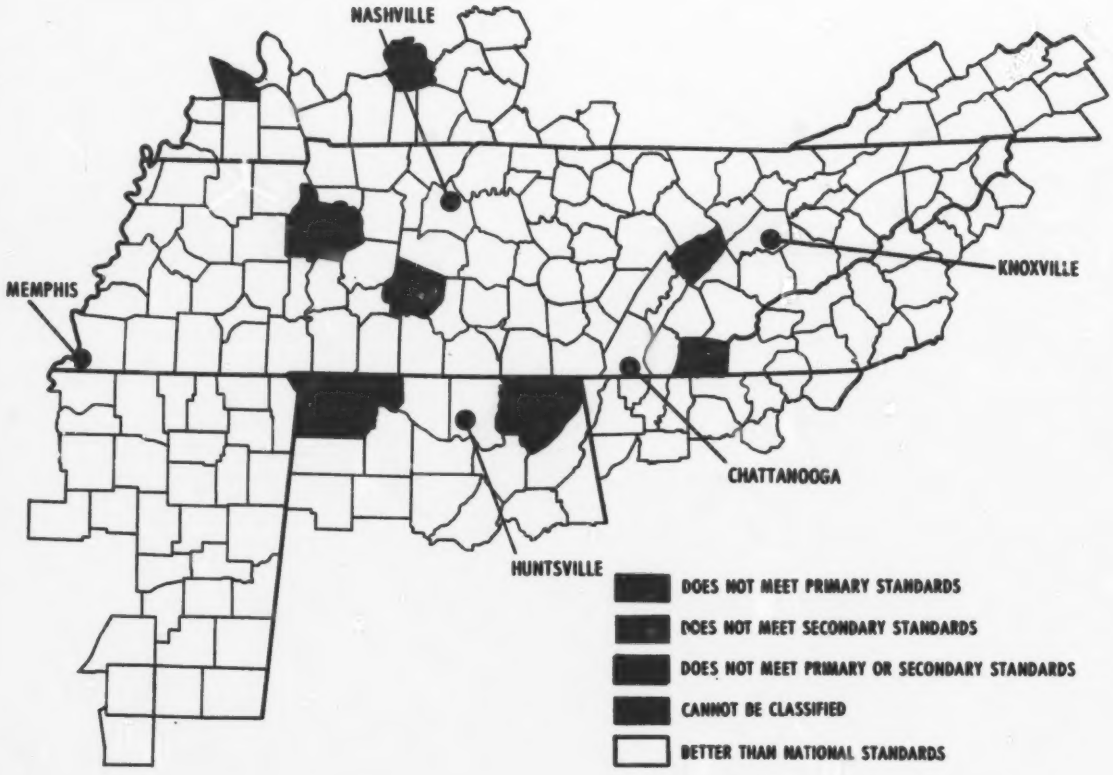
Nashville, Chattanooga, and Memphis all require more restrictive pollution control for existing sources. Two sources in Decatur have been placed on approved compliance schedules.

Nonattainment of NAAQS for total suspended particulates in the Kentucky areas of McCracken and Marshall Counties has been attributed to nontraditional sources. Extensions are proposed to study this problem. Compliance programs for existing sources are also planned for Marshall County.

The Tennessee nonattainment areas of Campbell and Maury Counties will require additional particulate control on existing sources and control of "fugitive" industrial emissions (those not emitted through a stack or vent). Also, Columbia (Maury County) will need an 18-month extension to develop a strategy for attaining secondary NAAQS, which are now being violated. Present plans call for redesignating the Rockwood (Roane County) nonattainment area to unclassifiable because of insufficient data.



Nonattainment areas for total suspended particulates.



Nonattainment areas for sulfur dioxide.

Sulfur Dioxide—Nonattainment of the NAAQS for sulfur dioxide is attributed to power plant emissions in all cases but one. This nonattainment area is located in Polk County, Tennessee, and is attributable to a chemical process facility at Copperhill. The tentative SIP revision for this area requires changes in stack design and restrictions in emissions from existing point sources. A request for additional time to study strategies for attaining the secondary NAAQS is also anticipated.

Both State and TVA monitoring showed that most violations of the NAAQS in the Valley for particulates and sulfur dioxide occurred near TVA steam plants. TVA has been identified as the prime contributor to these nonattainment problems. However, TVA is now engaged in a massive effort to meet all emission limitations at its steam plants by the end of 1982. This program calls for installation of continuous emission controls or use of low-sulfur coal to achieve the emission limitation established to maintain NAAQS near these plants. This program calls for annual reductions of greater than one million tons of sulfur dioxide. The table on the following page has been developed to show the attainment status near TVA steam plants and the control scheme that has been proposed for each plant.

NAAQS VIOLATIONS AND COMPLIANCE STRATEGY FOR TVA STEAM PLANTS

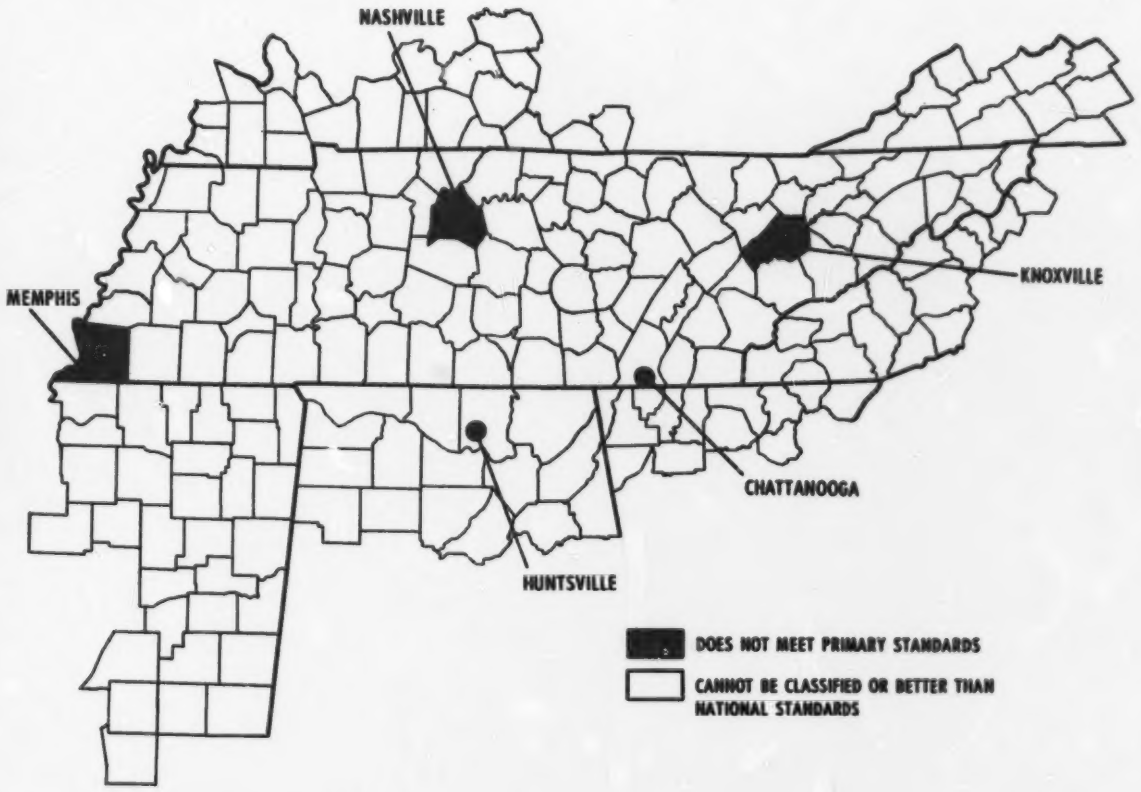
Plant	Nonattainment county	Nonattainment designation: Total suspended particulates Primary	Nonattainment designation: Total suspended particulates Secondary	Nonattainment designation: Sulfur dioxide Primary	Nonattainment designation: Sulfur dioxide Secondary	Control strategy: Total suspended particulates	Control strategy: Sulfur dioxide
				Alabama			
Colbert	Colbert/Lauderdale	Unclassified			X	N/A	Medium-sulfur coal
Widows Creek*	Jackson	X	X	X	X	Scrubbing (unit 7)	Low-sulfur coal (units 1-6) and scrubbing (units 7 and 8)
				Kentucky			
Paradise*	Muhlenberg	X	X	X	X	New precipitators (unit 3) plus scrubbing (units 1 and 2)	Coal washing plus scrubbing (1400-MW)
Shawnee*	McCracken	X	X	X	X	Baghouses	Low-sulfur coal
				Tennessee			
Allen**	Shelby					Modify precipitators	Medium-sulfur coal
Bull Run**	Anderson/Knox		X			New precipitators	N/A
Cumberland	Stewart					N/A	Coal washing
Gallatin**	Sumner	X		Unclassified		New precipitators	Medium-sulfur coal
Johnsonville	Benton/Humphrey			X	X	N/A	Scrubbing

*Violations of total suspended particulates not attributed to TVA steam plant alone.

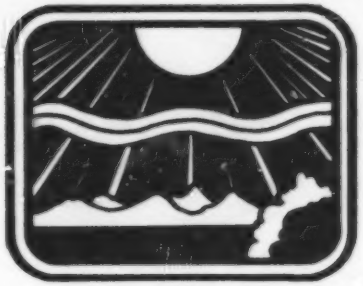
**Program complete.

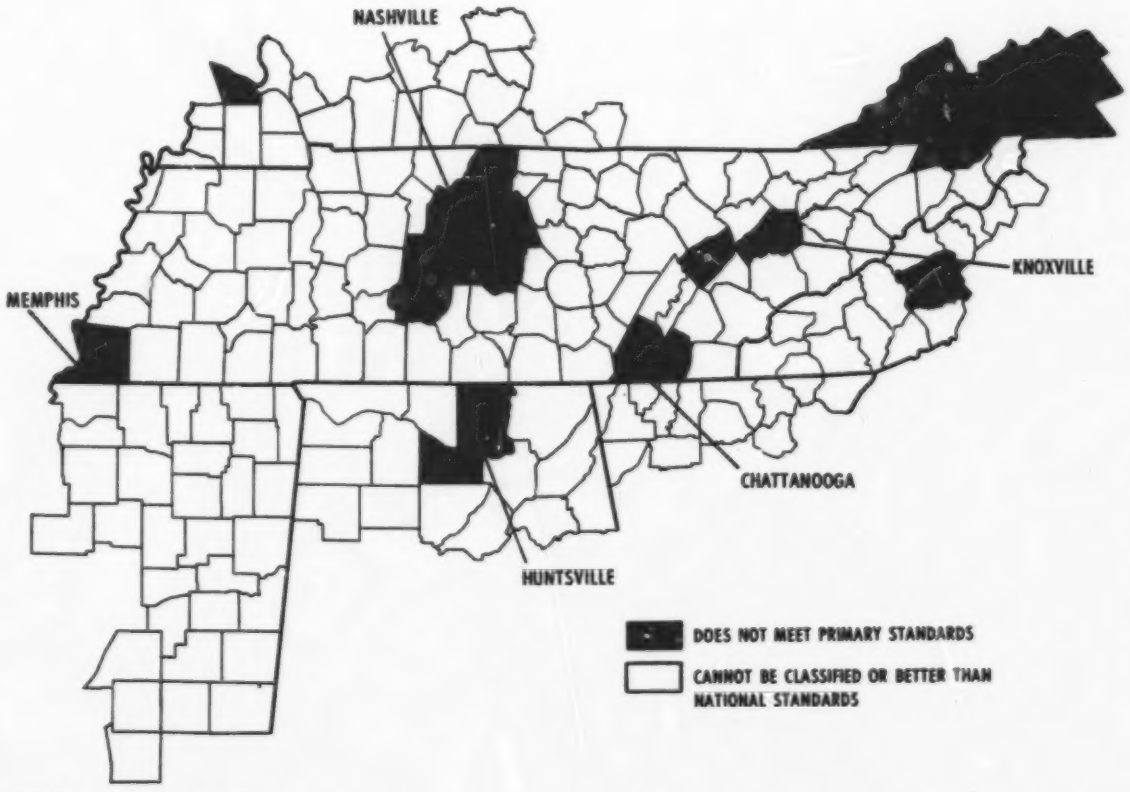
Carbon Monoxide—Nashville, Memphis, and Knoxville are nonattainment areas for carbon monoxide. Strategies for controlling carbon monoxide emissions include credit for continued emission reductions resulting from the Federal motor vehicle emission control program.

In addition to the Federal control program, both Nashville and Memphis are considering a mandatory inspection and maintenance program for vehicle emission control systems. Both cities will also need an extension until 1987 to comply with the NAAQS for carbon monoxide. Further analysis is being conducted to determine whether the inspection and maintenance program is necessary. Results of this analysis and the proposed actions are to be submitted to EPA for approval by 1982.



Nonattainment areas for carbon monoxide.





Nonattainment areas for ozone.

Ozone—Nashville, Chattanooga, Knoxville, Kingsport, Huntsville, Decatur, and Memphis exceeded the revised NAAQS for ozone in 1977. Strategies for controlling ozone emissions include credit for continued emissions reductions resulting from the Federal motor vehicle emission control program.

Of the urban areas, only Nashville has a severe enough problem to require a mandatory inspection and maintenance program for vehicle emission control systems. Nashville has proposed an extension until 1987 to comply with the ozone standard. All urban areas will require more stringent control of existing hydrocarbon emission sources.

The SIP revisions are not required to show attainment of the ozone standard for nonurban areas. Transport processes are believed to play a major role in the high levels of ozone in nonurban areas. Therefore, controlling ozone emissions in the urban areas and emissions of volatile organic compounds (VOC) from major stationary sources should lead to attainment of the ozone NAAQS in nonurban areas as well. A plan for growth potential in rural areas will not have to be provided. After a Statewide SIP has been approved, VOC sources can locate in rural areas without emission offset if they use best available control technology in controlling emissions.

Protecting and Maintaining Clean (Attainment) Areas

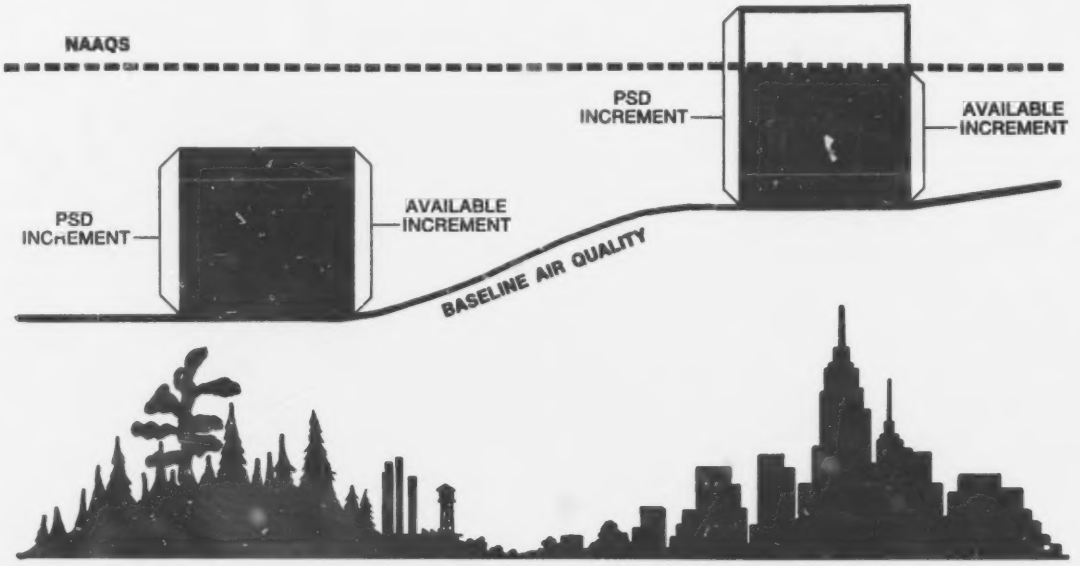
The Clean Air Act of 1977 provides for the prevention of significant deterioration (PSD) of air quality in attainment areas. One significant objective of these requirements is to ensure that "economic growth will occur in a manner consistent with the preservation of existing clean air resources."

The PSD provisions of the Act require the designation of all areas of the Nation where the NAAQS are being attained as Class I (maximum protection), Class II (moderate growth allowed), or Class III (minimum limitation on growth).

To build a new major source or to greatly modify an existing source in an attainment area, the owner must:

- Provide an air pollution control system that incorporates the best available control technology and that considers energy, environmental, and economic impacts and other costs.
- Demonstrate that the NAAQS will not be threatened and that the allowable PSD increments will not be exceeded as a result of operation of the new or modified source or of growth associated with the new source.
- Demonstrate that the new or modified source will not adversely affect air-quality-related values such as impacts on soils, vegetation, visibility, odor, or climate in any PSD Class I area. (Class I areas include national parks and wilderness areas.)

For attainment areas, maximum allowable increases (increments) in ambient pollutant concentrations have been established for sulfur dioxide and total suspended particulates. The Clean Air Act requires EPA to establish allowable increments for the five remaining pollutants.



The NAAQS are established limits of pollutant concentration, in micrograms per cubic meter, that apply for the entire United States; PSD increments are a given pollutant concentration that may be added to a baseline concentration. Baseline air quality may vary from place to place.

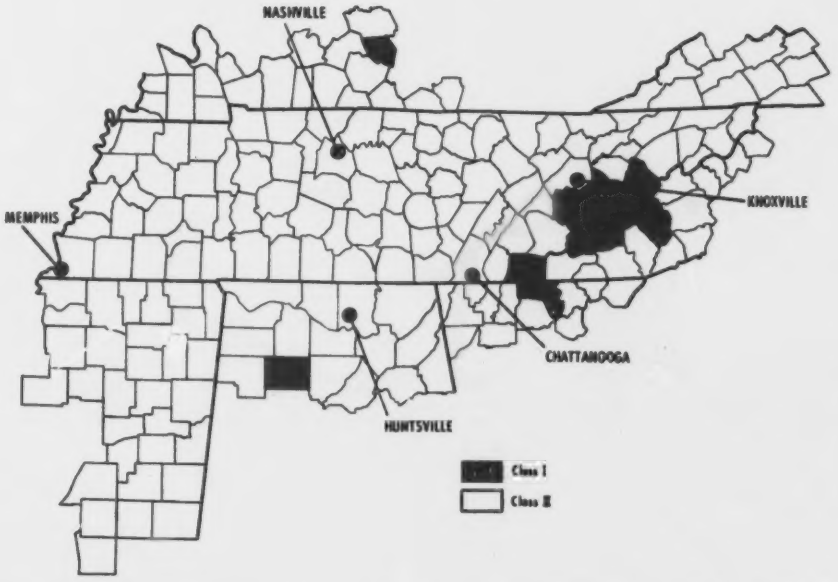
In the example on the left, the NAAQS level is met, even after adding the increment to the baseline. Thus, a measure of pollutant increment is available for new industrial growth.

In the example on the right, the baseline concentration is so high that adding the increment would cause exceedance of the NAAQS. In this case, the maximum pollutant concentration is limited to the NAAQS, and only part of the increment is available for new growth.

Protecting Class I Areas—In the Clean Air Act Amendments of 1977, Congress declared that "national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural recreational, scenic, or historic value required designation as mandatory Class I areas." These areas are to be strictly protected from new sources of sulfur dioxide and total suspended particulates and from new and existing sources of visibility degradation. Protecting the natural integrity of these select environments, although crucial to many Americans, will probably prove to be an extremely difficult task.

Eight Class I areas can affect pollution control strategies in the Tennessee Valley region: Great Smoky Mountains National Park, Tennessee and North Carolina; Joyce Kilmer-Slickrock Wilderness, North Carolina; Linville Gorge Wilderness, North Carolina; Shining Rock Wilderness, North Carolina; Cohutta Wilderness, Georgia; Sipsey Wilderness, Alabama; Mingo Wilderness, Missouri; and Mammoth Cave National Park, Kentucky.

In 1977 Congress declared that all major national parks and wilderness areas will be protected by designation as Class I areas.



Class I and Class II areas. (The nonattainment areas shown in the previous maps are not included in PSD classifications.)

The eastern half of the TVA service area is generally characterized by rugged, mountainous terrain. This terrain and the proximity of Class I areas will affect growth of major new sources in the eastern Tennessee Valley area. The western half of the TVA service area, however, is characterized by flat or rolling terrain. Growth of major new sources in the western Tennessee Valley is not expected to be significantly impacted by either Class I areas or the topography.

To ensure protection of air quality within these Class I areas, industrial growth may require installation of stringent pollution controls. Depending on the size of the source, these stringent controls may be required on sources located up to 100 kilometers from the Class I area.

Sulfur dioxide, by itself, is not expected to pose a problem in these Class I areas, because background levels are often below the detectable limits of the monitoring instruments. However, visibility degradation, which is caused by both gaseous (for example, nitrogen dioxide) and particulate (for example, suspended sulfate) pollution, may result in control of both gaseous and particulate precursors (nitrogen oxides and sulfur dioxide).

Maintaining Class II Areas—The Clean Air Act Amendments of 1977 initially designate all PSD areas, except for Federally mandated Class I areas, as Class II areas. Class II areas are areas in which moderate industrial development will be allowed. The 1977 amendments also provide that a State may redesignate selected areas as Class III areas after concurrence by local governments and a public hearing process. Class III areas are areas which would allow even greater industrial development than would Class II areas.

The table on the right lists the allowable increments of additional pollution allowed in each clean area and compares these with the NAAQS. These increments, when added to the ambient air quality levels that existed on August 7, 1977, cannot exceed the NAAQS. Therefore, in many areas of the region, the entire increment may not be available for new growth.

ALLOWABLE INCREMENTS OF ADDITIONAL POLLUTION FOR CLASS I, CLASS II, AND CLASS III AREAS

Time period*	Ambient standards (micrograms per cubic meter)		Allowable increments (micrograms per cubic meter)		
	Primary	Secondary	Class I	Class II	Class III
Particulate matter					
Annual geometric mean	75	60	5	19	37
24-hour maximum	260	150	10	37	75
Sulfur dioxide					
Annual arithmetic mean	80	-	2	20	40
24-hour maximum	365	-	5	91	182
3-hour maximum	-	1300	25	512	700

*Short-term standards (24 hours and less) are not to be exceeded more than once a year. Long-term standards are maximum permissible concentrations that are never to be exceeded.

Managing The Air Resources

Achieving air quality goals in the Tennessee Valley is possible. It will require a delicate balancing of many apparently conflicting interests by policy-makers, administrators, and other officials on Federal, State, and local levels. Environmental regulations will require realistic goals—goals high enough to protect human health and the natural environment, but not so high as to severely impair the local economy on which people depend for jobs, incomes, products, and services.

Government Involvement

These balances are already beginning to appear in environmental regulations. The offset provisions of the clean air regulations are one example. Allowing a local area to use pollution reductions by one source to offset emissions by another should ensure acceptable air quality while allowing economic growth. It is at the local level where Federal environmental programs must ultimately work.

Congress has emphasized the role of State and local officials in carrying out the Clean Air Act. EPA is giving the States and local governments more responsibility in achieving a cleaner environment. Local communities must consider the effect that environmental protection strategies will have on traffic patterns, land use, housing, economic development, and urban sprawl.

City officials know that the country's air quality problems are most acute in the urban areas. A national problem cannot be solved at the local level without involving local government. The increase in Federal decentralization is shifting more decisions and responsibilities to State and local governments, thus placing the decision-maker closer to the problem.

Local governments must be able to weigh the economic, social, energy, and environmental costs and benefits of various strategies to find the approaches that meet the individual needs of each city and town.

No boundary lines exist for pollution. Air emissions from one area can soon impact a neighboring, or even distant, area. For this reason, improvements in air quality must be planned on a regional basis. Local officials must be included as participants in the planning process—not just the beneficiaries, or perhaps victims, of it.

The people of the Tennessee Valley region have the opportunity to implement measures to ensure quality growth. Quality growth can be achieved when community leaders, industrial interests, and environmental groups collectively study the problems and needs of communities and then work together to improve the community and the region as a whole. Federal and State agencies should provide assistance to areas faced with unusually complex problems and technical requirements that may be regional in nature.

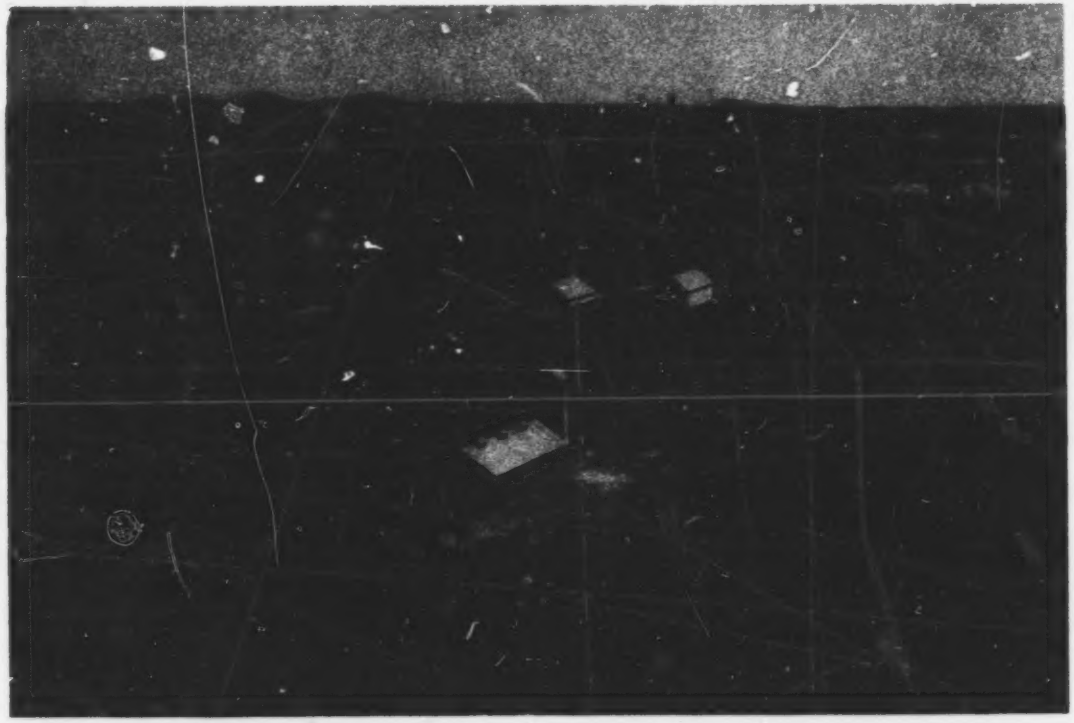
Achieving air quality goals while promoting economic development in the Valley will require interaction and cooperation among industrialists, environmentalists, and all levels of government.

TVA Involvement

TVA cooperates with all State and local agencies responsible for guiding economic and industrial development in the region. TVA, through its monitoring and research activities, can supply some of the air quality information necessary for making decisions about land use planning.

Such information can be distributed through various community-agency interfaces. For example, a comprehensive land use planning and management program is provided for TVA reservoir lands. Through this program, TVA gathers information on air, water, and land resources for these areas and the communities and counties adjacent to TVA lands. Using this information, TVA provides development assistance to those communities that request help and for which assistance is not available through other Federal or State programs. This program provides an opportunity for technology transfer and for demonstration of methods for incorporating air quality data into land use and economic development decisions.

A more direct approach for providing comprehensive air quality input to land use planning decisions would be to supply the necessary information directly to community and county decision-makers. TVA could supply data and methods for analysis or actually perform the data analyses and provide technical assistance in assessing the impact of the proposed community action (for example, the siting of an industrial park or a single industry) on local air quality. Incorporation of the air quality information into an integrated land use policy decision is then the responsibility of the community. The nature and extent of the information supplied by TVA would depend on the needs and desires of the community.



Land use planning that considers environmental constraints will allow industrial growth while maintaining air quality that will not harm vegetation, materials,or human health.

TVA's industrial development program assists State, regional, and local development agencies by providing resource data and engineering support for planning and accommodating industrial expansion in the region. Air resources are important for selecting industrial sites and in some parts of the region are the most critical factor. TVA could help achieve quality industrial growth in the nonattainment areas of the region by assisting in demonstration of the emissions offset policy. New industries may locate in nonattainment areas by reducing emissions from existing sources in the area. Those urban areas containing major industrial sources provide an excellent opportunity for demonstrating innovative methods of promoting economic development and creating new jobs while achieving clean air goals.

TVA can also provide an important function in energy conservation by demonstrating various new technologies—waste heat utilization, energy-based industrial parks, coal beneficiation, fuel cell technology, atmospheric fluidized-bed combustion, electric and hybrid vehicles, public transportation, and use of coal to reduce consumption of petroleum. All these technologies can contribute to the solution of our energy problems. A region-wide public transportation system aimed at reducing the number of individual automobiles can significantly reduce hydrocarbon, carbon monoxide, and nitrogen oxide emissions from mobile sources as well as reduce gasoline consumption. Some of these technologies may provide future relief for existing conventional coal-fired power plants and their inherent air pollution problems.

TVA's conservation programs include a region-wide insulation and weatherization program for homes heated and cooled with electricity, a program for promoting the use of heat pumps, a new commercial and industrial conservation program, and demonstrations in solar water and space heating. All of these programs are aimed at the more efficient use of electricity. Conservation measures such as these will affect peak power demand, resulting in more efficient operation of TVA power plants. This increase in efficiency will, in turn, further reduce atmospheric emissions from the coal-fired plants and the oil-fired generators used during peaking.

Installation of conservation measures in the home and development of solar facilities throughout the Valley will conserve energy, lower electric bills, and have an overall effect of reducing atmospheric emissions from steam plants.

Industry Involvement

Industrial leaders must be willing to work with community leaders in providing progressive planning for the future. They should be willing to commit both financial and technological resources to achieve the reduction of air and water pollution. Existing industries should be willing to work with new industries to achieve long-range goals and plans that will benefit the entire community, not just an individual industry. Such progressive measures will ensure attainment of air and water quality goals and will protect and enhance these limited resources for future generations.

For information or additional copies, contact
Information Services
Division of Natural Resources Services
Tennessee Valley Authority
201 401 Building
Chattanooga, TN 37401
(615) 755-3141

TENNESSEE VALLEY AUTHORITY

November 1979